Lucia Gibilaro, Gianluca Mattarocci

Banking Group Features and Interbank Market Exposure: Evidence from the Main European Groups

(doi: 10.12831/83858)

Journal of Financial Management, Markets and Institutions (ISSN 2282-717X)
Fascicolo 1, gennaio-giugno 2016

Ente di afferenza:
()

Banking Group Features and Interbank Market Exposure: Evidence from the Main European Groups

JFMI
Journal of Financial Management Markets and Institutions

Lucia Gibilaro
Università di Bergamo

Gianluca Mattarocci
Università di Roma «Tor Vergata»

Abstract

Banking group affiliation could affect both the asset and liability side of the interbank exposure of a bank due to the strict relationship between all of the group's members.

Considering a representative sample of all of the main European banks for 2005-2010 timeframe, we study the relationship between interbank exposure (asset side, liability side and the net exposure) with respect to bank characteristics, market dynamics and group structure characteristics. Results demonstrate that interbank exposure is not only driven by banks' and market features as confirmed by the literature, but also by group features, even if during the financial crisis something changed.

Keywords: Banking group; Interbank market; Financial crisis.
JEL Codes: G21; G15; G32.

1 Introduction

Interbank markets are among the most important of all the financial markets, because they allow immediate transfers of liquidity from a surplus entity toward a deficit entity (Allen *et al.*, 2009). Bilateral lending relationships are developed (Cocco *et al.*, 2009) that can be affected by corporate control because of the high relevance of cross border lending toward entities of the same group (Wells, 2004), as takeovers among banks are also intended to diversify away liquidity shocks inside the banking group (Focarelli *et al.*, 2002).

Therefore for banking groups, a money centre structure applies (Freixas *et al.*, 2000), where each bank trades directly with a reference bank only and, as a consequence, interbank activity is mostly traded among banks belonging to the same group. Thus, interbank intermediation among a banking group is described as a multiple money center structure (Degryse and Nguyen, 2007) coherent with a tiered market (Craig and Von Peter, 2014).

Corresponding author: Lucia Gibilaro, lucia.gibilaro@unibg.it, tel +390352052675, Department of Management, Economics and Quantitative Methods, via dei Caniana 2, 24127 Bergamo.
Gianluca Mattarocci, gianluca.mattarocci@uniroma2.it, tel. +390672595903, Department of Management and Law, via Columbia 2, 00133 Rome.

ISSN 2282-717X

In this perspective, corporate control plays a critical role among firm characteristics that explain banks' role and strategies to satisfy liquidity needs in the interbank market (Cajueiro and Tabak, 2008). In fact, for banks affiliated with banking groups, liquidity management is virtually centralised (Schinasi and Teixera, 2006), lacks regulatory constraints, and can be considered fungible inside the banking group (Cumming and Hirtle, 2001). As a consequence the liquidity needs of a group member are a function of the correlation between the cash flows of the group entities (D'Souza and Lai, 2006). Therefore, the liquidity needs of the group are affected by the possible synergies existing among its members (Vander Vennet, 2002). In turn, the structure of interbank relationships among the entities within the same network plays a crucial role in the liquidity spill-over effects. Less homogeneous structures can be associated with a higher number of failures (Memmel and Sachs, 2013) and with more serious impacts (Mueller, 2006).

This article examines the interbank market exposure of the main European banking groups over the 2005-2010 period. In light of fitting the multi money center structure for banking groups at the aggregate group level, the article tests a hypothesis about the role of banking group features (Cajueiro and Tabak, 2008) in explaining the consolidated interbank exposure of banking groups. As a result of the relevance of both market and specific factors affecting liquidity risk exposure (Bangia *et al.*, 1999), we consider the credit both offered and obtained in the interbank market for each banking group (Affinito, 2012) in each year. We also study their relationship with balance sheet indexes (Iyer and Peydró, 2011; Craig and Von Peter, 2014), market dynamics (Allen *et al.*, 2009; Craig and Fecht, 2007) and, as original contribution, we supplement them with group control features. As group structure affects the interactions between group members (Cohen *et al.*, 1961), the study of the evolution of corporate control structure proxies the group dynamics.

For banking groups, the importance of this issue analysed in the article is related to the huge interbank transmission of liquidity among them (Cabral *et al.*, 2002). Therefore it contributes to understanding the relationship between group features and the recourse to the interbank market. From the macroeconomic perspective, this article also relates the stability of the financial system to the relationship between interbank lending and systemic risk (Upper and Worms, 2004) that can lead to market breakdown during financial crisis (Furfine, 2002). Moreover, under the contagion mechanism the analysed net exposure represents the potential loss suffered by the financial system if the parent company is unable to recapitalize the affiliated entities, by assuming the hypothesis of perfect dispersion of the exposures (Mistrulli, 2011).

The results demonstrate that interbank exposure is significantly affected by group features. More profitable groups rarely make use of the interbank market, while bigger groups appear to drain liquidity from the interbank market, raising concerning for potential systemic effects. Among market dynamics, credit offered by the Central Bank negatively affects group activity on the interbank market. Corporate control features of the group affect interbank exposure in several ways: the higher the number of the controlled entities, the lower the lending activity in the market is, while the geographical concentration of the group, public ownership and cooperation are associated with a negative net exposure. In light of the results and due to the relevance of the interbank market in systemic risk, changes in the

corporate control of banking groups are significant for the purpose of financial soundness and stability, with important macro and micro implications for banking consolidation in Europe (Udhe and Heimeshoff, 2009). Moreover, the results point out some changes in the strategies adopted by banking groups in accessing the market under crisis context, with potential impact on the drying up of liquidity between 2007 and 2009 (Cornett *et al.*, 2011).

This article contributes to the extant literature in many directions. To the best of our knowledge, this is the first contribution that delves into the linkage between banking group dynamics and interbank market exposure under a micro perspective. More than considering firm accounting features, the research introduces new explanatory variables concerning the control structure of the group computed on an historical bottom up review of group structures. Moreover, in line with previous literature (e.g. Angelini *et al.*, 2011), the study contributes to the debate on the impact of the recent financial crisis on the interbank market by covering a medium term timeframe. Lastly, following studies on internal markets at multinational banking groups (e.g. de Haas and Lelyveld, 2010) the article offers the opportunity to test if acknowledged variables for banks in their recourse to the interbank market hold at group level.

In this article, we present a literature review about the firm-specific factors that affect access to the interbank market by banks and we discuss the rationale of the relevance of group structure in using the interbank market to overcome liquidity shocks (Section 2). After a brief description of the sample (Section 3.1), we present a methodology for testing the relevance of group features, market dynamics and bank characteristics in accessing the interbank market (Section 3.2), providing the definition of the variables (Section 3.3), summary statistics and correlation analysis (Section 3.4). Results about the lending activity, the borrowing activity and the net interbank position are presented separately with respect to the determinants of their value (Section 3.5), and they are then complemented by a robustness test (Section 3.6). The last section summarises the conclusions and the implications of the results (Section 4).

2 Literature review

Banks access the interbank market to satisfy their liquidity needs because of the risk of liquidity shortages arising from the uncertainty both in the location (Freixas *et al.*, 2000) and the time of consumption (Allen and Gale, 2000). Banks can diversify away liquidity shocks by developing bilateral lending relationships with other banks (Upper and Worms, 2004) under corporate control because of the high relevance of cross border lending toward entities of the same group (Wells, 2004), and as takeovers among banks are intended to diversify away liquidity shocks inside the banking group (Focarelli *et al.*, 2002).

Both market and firm-specific factors influence the liquidity risk exposure (Bangia *et al.*, 1999) and the price of liquidity (Fecht *et al.*, 2011). Therefore, banks' roles and strategies to satisfy liquidity needs in the interbank market can be affected by firm characteristics, such as corporate control, market segment and size (Cajueiro and Tabak, 2008).

For privately controlled firms, access to the interbank market for the purpose of adjusting liquidity position is affected by corporate control: for groups, the liquidity needs of the group member are affected by the correlation between the cash flows of the group entities (D'Souza and Lai, 2006). In fact, the structure of a group enables it to operate in different sectors by flexibly exploiting the possible synergies existing among its members (Vander Vennet, 2002). However, this advantage is countered for large groups by a potential increase in the risk level because of the increase in leverage and the decrease in capital ratios (Demsetz and Strahan, 1997). Lacking regulatory constraints, liquidity can be considered fungible inside the banking group (Cumming and Hirtle, 2001); therefore, liquidity management is virtually centralised for the firm as a whole (Schinasi and Teixera, 2006), and resources are allocated to the business units through a system of internal transfer rates (Matz and Neu, 2007). The centralisation of liquidity risk management is motivated by the fostering of efficiency through the reduction of funding costs, the opportunity of funding diversification and the feasibility of moving collateral and funds among business units (Joint Forum, 2006). Nevertheless, cross-border group structures encourage the management of liquidity at the local level, even though the group must centrally oversee liquidity management, irrespective of the level of decentralisation implemented (Institute of International Finance, 2006). To overcome the disadvantages in accessing liquidity due to their limited size (Ehrmann and Worms, 2004), savings and cooperative banks can create group networks, in which a head institution or more second-level institutions hold liquidity reserves and coordinate the reallocation of liquidity among the members (Mazzillis and Schena, 2001).

The group composition according to entity type is relevant because the market segment affects liquidity creation by banks (Berger and Bouwman, 2009). Liquidity need depends primarily on retail deposits (Ho and Saunders, 1985) because depositors are permitted to withdraw at low cost (Diamond and Rajan, 2001). As such retail banks access the unsecured interbank market more frequently to hold higher liquid buffers that can be mitigated if a less-than-perfect correlation holds between demand deposits and loan commitments (Kashyap *et al.*, 2002). For banks focused on investment activities, short-term collateralised borrowing is more relevant to satisfy their liquidity needs (Adrian and Shin, 2008).

Size affects the attitude of the bank toward wholesale funding, including access opportunity (Allen *et al.*, 1989) and price of the funds obtained (Nyborg *et al.*, 2002). Size matters for banking groups because of economies of scope and scale (Altunbas and Molyneux, 1996). Concerning liquidity, a large financial entity has better access to interbank markets, for example, because it has a larger network of regular counterparties, particularly in the case of banks labeled «too big to fail», or because it has a wider range of collateral to satisfy liquidity needs through the secured market (Fecht *et al.*, 2011).

Empirical analysis during the current financial crisis demonstrates that on average the number and size of exposures in the interbank market decreased significantly and the effect of the crisis has been different on the basis of country affiliation and some other specific features (e.g. size) of the bank (Hale, 2012). Fund flows are affected by the choice of considering either bank or group data, and empirical evidence demonstrates that during the crisis financial groups tended to internalise transactions and reduce the

exposures with other banks (Garratt *et al.*, 2014). The literature does not provide empirical evidence on the main group features that drive a higher or lower interbank exposure in a crisis scenario.

3 Empirical analysis

3.1 Sample

According to Bankscope rankings, we consider the top 500 banking groups worldwide based on total assets in 2010. We focus our attention only on those that are based in the enlarged European Union because they are more homogeneous under the definition of EU legislation concerning the exercise of banking and financial activity, and as the relevant markets show a high level of financial integration. The vast majority of the banking groups are based in Euro countries with the exception of a limited percentage of entities that are based in countries that have either adopted currencies that show co-movements with the Euro (Bartram *et al.*, 2005), in the case of UK and Scandinavian countries, or show convergence in terms of volatility in the case of Central Europe countries (Babetskaia-Kukharchuk *et al.*, 2008). For Euro countries (Baele *et al.*, 2004) and Eastern Europe countries (Chelley-Steeley, 2005) where banking groups are resident, integration is a main feature of financial markets (Baele *et al.*, 2004), while the UK does not exhibit such a feature (Hardouvelis *et al.*, 2006). From the initial sample, we also exclude all the groups for which the solo balance sheet is not available or the details of the structure and ownership relevant under the control perspective are not provided (the final number of banking groups is 49). The full list of groups considered is presented in Table 1.

Because of the availability of data, we consider the 2005 to 2010 period, and we collect yearly data (coherently with Mistrulli, 2011 and Dinger and Von Hagen, 2009) from the consolidated income statement and balance sheet of each banking group. The use of consolidated data is motivated by the fact that intragroup exposures are relevant only for the internal market (Craig and Von Peter, 2014), and by the evidence that liquidity is virtually centralised inside banking groups (Joint Forum, 2006). As such group entities are supposed to stand or collapse all together (Wells, 2004) depending on the strength of the parent company that supports them (de Haas and Lelyveld, 2010).

Based upon the data available in Bankscope and following the approach proposed by Upper and Worms (2004), we construct our proxy of liquidity risk considering loans and deposits to banks, and the difference between the two proxies. Following the literature, we identify and construct indexes and proxies that are useful in explaining the liquidity exposure of each banking group.

To evaluate the role of group characteristics (de Haas and Levyveld, 2010) in explaining liquidity risk exposure, we also collect information about the group rating (our proxy is the Fitch support rating, which measures the quality of the banking groups on the basis of the characteristics of the holding and other group members). We analyse the ownership of each group member, the type of subsidiaries and holdings (bank vs.

Table 1: Sample description

Denomination	Registered office	Denomination	Registered office
HSBC Holdings Plc	UK	Raiffeisen Landesbanken Holding GmbH	DE
BNP Paribas	FR	Skandinaviska Enskilda Banken AB	SE
Banco Santander SA	SP	Caja Madrid-Caja de Ahorros y Monte de Piedad de Madrid	SP
Barclays Plc	UK	Dexia	BE
UniCredit SpA	IT	Deutsche Zentral-Genossenschaftsbank-DZ Bank AG	DE
Genossenschaftlicher FinanzVerbund	DE	Swedbank AB	SE
Lloyds Banking Group Plc	UK	Landesbank Baden-Wuerttemberg	DE
Intesa Sanpaolo	IT	Svenska Handelsbanken	SE
Société Générale	FR	Banco Popular Espanol SA	SP
Deutsche Bank AG	DE	European Financial Group EFG (Luxembourg) SA	LU
Rabobank Group-Rabobank Nederland	NL	Ages	BE
Banco Bilbao Vizcaya Argentaria SA	SP	Banco Espirito Santo SA	PT
Credit Mutuel – IFRS	FR	Espirito Santo Financial Group S.A.	LU
BPCE SA	FR	Millennium bcp-Banco Comercial Português, SA	PT
Standard Chartered Plc	UK	Nationwide Building Society	UK
Commerzbank AG	DE	Mediobanca SpA	IT
Nordea Bank AB (publ)	SE	EFG Eurobank Ergasias SA	GR
LA CAIXA-Caja de Ahorros y Pensiones de Barcelona	SP	Caja de Ahorros de Valencia Castellon y Alicante BANCAJA	SP
KBC Group-KBC Groep NV/ KBC Groupe SA	BE	Norddeutsche Landesbank Girozentrale NORD/LB	DE
NRW.BANK	DE	Banco de Sabadell SA	SP
Gruppo Monte dei Paschi di Siena	IT	Allied Irish Banks plc	IR
Erste Group Bank AG	DE	DekaBank Deutsche Girozentrale	DE
Danske Bank A/S	DK	WestLB AG	DE
UBI Banca-Unione di Banche Italiane Scpa	IT	Landwirtschaftliche Rentenbank	DE
Banco Popolare	IT		

Source: Bankscope data processed by the authors.

other), the country of each groups' members and the role of controlled subsidiaries with respect to others. For group structure and ownership, Bankscope only provides the last available data and so we use information available in the solo balance sheet of each banking group to reconstruct all the changes that occurred over the six year time horizon.

A preliminary analysis of the sample composition, based on some summary statistics computed on the last available data, demonstrates that the groups are quite heterogeneous with regard to these features (Table 2).

Considering the reference country for each group member, less than the 20% of the groups considered operate in only one country, and only 10% operate in more than 20 countries. The groups considered are prevalently non-cooperative banks (only 10%), not public owned (only 14%), and the reference entity (holding) is normally a bank or a financial institution (more than 73%).

Table 2: Groups' control structure

Mean number of countries for each group		Cooperative banks[1]	Non cooperative banks
Only one country	4	5	44
From 2 to 10	23	Public ownership*	Non public ownership*
From 11 to 20	12	7	42
Over than 20	10	Holding bank	Other type of Holding
Ratio controlled subsidiaries/Overall		36	13
Mean	35.46%	Ratio banks controlled/Overall controlled	
Median	27.05%	Mean	18.14%
Min	0.00%	Median	13.85%
Max	100.00%	Min	1.33%
		Max	62.86%

Note: * We do not consider the effect of Nazionalisation during the financial crisis.
[1] «Cooperative banks» means banking groups of savings and cooperative entities. The classification was provided by Bankscope.

Source: Bankscope data processed by the authors.

Group members' shares owned by the holding represent are on average less than 36%, therefore other members participation does not imply corporate control. In terms of the types of controlled entities, not all of them are banks; the banking group frequently decides to control other types of firms also (non-financial ones).

To determine the impact of interest rate market dynamics (e.g., Furfine, 2001), we also collect information about the marginal lending facility amount and the EONIA interbank loan rate directly from the ECB website.

3.2 Methodology

Following the approach proposed by Upper and Worms (2004) on estimating interbank exposure with undisclosed counterparties, the link between the banking group features and the interbank market exposure is analysed by considering different proxies:

$$(1) \qquad Asset\ side_{it} = Loans\&Advances\ to\ Banks_{it}$$

$$(2) \qquad Liability\ side_{it} = Deposits\ from\ Banks_{it}$$

$$(3) \qquad Net\ exposure_{it} = Liability\ side_{it} - Asset\ side_{it}$$

Formula (1) computes the investment released by a banking group in interbank market lending activity considering the overall exposure at the end of the year t related to loans and advances. The variable constructed considers all of the main investments made by the group on the interbank market (Cocco *et al.*, 2009).

Formula (2) computes the exposure on the interbank market, considering only the deposits obtained by banks. The choice to exclude secured debt is consistent with other studies available in the literature that demonstrate that only deposits show dynamics that are not affected by specific contract characteristics (e.g., Cajueiro and Tabak, 2008).

Formula (3) considers the difference between the asset and liability side of liquidity exposure because the effects of market conditions on the strategy are determined by the

net position of each banking group (Wong, 1997). On one side, banks accessing the interbank market for liquidity management are compelled to deposit funds if they are also net takers, in particular if they are distant from the holding company; on the other side, banks play on both sides of the interbank market to exploit the best quotations when the need for liquidity emerges (Dematté, 1981).

The choice to consider debt and credit exposure independently with respect to the size of the exposure could be useful because there is evidence that demonstrates the role of specific bank features in explaining the exposure in the interbank market (e.g., Iori *et al.*, 2007). To reduce the noise of the data analysed, we transform the explained variables into dummy variables that allow us to study the main features that explain an over-exposure in the interbank market (on both the asset and liability side) and the positive net exposure in the market. In formulas:

$$Asset\ side\ Binary_{it} = \begin{cases} 1\ if\ \ Asset\ side_{it} \geq Median_t \\ 0\ if\ \ Asset\ side_{it} < Median_t \end{cases} \tag{4}$$

$$Liability\ side\ Binary_{it} = \begin{cases} 1\ if\ \ Liability\ side_{it} \geq Median_t \\ 0\ if\ \ Liability\ side_{it} < Median_t \end{cases} \tag{5}$$

$$Net\ exposure\ Binary_{it} = \begin{cases} 1\ if\ \ Net\ exposure_{it} \geq 0 \\ 0\ if\ \ Net\ exposure_{it} < 0 \end{cases} \tag{6}$$

Formulas (4) and (5) are dummy variables that assume value 1 if, respectively, the asset side and liability side exposure are higher than the median value of the sample and zero otherwise.

Formula (6) considers the sign of the difference between the interbank exposure liability side and asset side only, and classifies the banking groups that at time *t* have a net exposure equal or greater than zero as debtors (value 1) and all the others as investors (value 0).

We perform panel regression analysis of the value of liquidity risk exposure (asset side, liability side and net exposure) with respect to some explanatory variables identified in the literature relating to the accounting characteristics of the group (*Firm*), market dynamics (*MKT*) and the corporate control structure (*Group*). The following formulas are tested:

$$Asset\ side_{it} = \alpha_t + \sum_{k=1}^{n} \beta_{it}^{k} Firm_{it} + \sum_{p=1}^{n} \gamma_{it}^{p} MKT_t \tag{1a}$$

$$Asset\ side_{it} = \alpha_t + \sum_{k=1}^{n} \beta_{it}^{k} Firm_{it} + \sum_{p=1}^{m} \gamma_{it}^{p} MKT_t + \sum_{q=1}^{o} \tau_{it}^{q} Group_{it} \tag{1b}$$

$$Liability\ side_{it} = \alpha_t + \sum_{k=1}^{n} \beta_{it}^{k} Firm_{it} + \sum_{p=1}^{n} \gamma_{it}^{p} MKT_t \tag{2a}$$

$$Liability\ side_{it} = \alpha_t + \sum_{k=1}^{n} \beta_{it}^{k} Firm_{it} + \sum_{p=1}^{m} \gamma_{it}^{p} MKT_t + \sum_{q=1}^{o} \tau_{it}^{q} Group_{it} \tag{2b}$$

$$Net\ exposure_{it} = \alpha_t + \sum_{k=1}^{n} \beta_{it}^{k} Firm_{it} + \sum_{p=1}^{n} \gamma_{it}^{p} MKT_t \tag{3a}$$

$$Net\ exposure_{it} = \alpha_t + \sum_{k=1}^{n} \beta_{it}^{k} Firm_{it} + \sum_{p=1}^{m} \gamma_{it}^{p} MKT_t + \sum_{q=1}^{o} \tau_{it}^{q} Group_{it} \tag{3b}$$

Based on the Hausman test results, the panel regression model considers random effects and standard errors clustered at bank level.

To isolate the impact of the size on the investigated interbank exposures, we perform a logit panel regression analysis of the binary transformation of the interbank exposure, that is asset side binary, liability side binary and net exposure binary with respect to the explanatory variables introduced in the regressions of the interbank exposure value. Therefore, the following formulas are studied:

$$\text{(4a)} \qquad \textit{Asset side Binary}_{it} = \alpha_t + \sum_{k=1}^{n} \beta_{it}^{k} \textit{Firm}_{it} + \sum_{p=1}^{n} \gamma_{it}^{p} \textit{MKT}_t$$

$$\text{(4b)} \qquad \textit{Asset side Binary}_{it} = \alpha_t + \sum_{k=1}^{n} \beta_{it}^{k} \textit{Firm}_{it} + \sum_{p=1}^{m} \gamma_{it}^{p} \textit{MKT}_t + \sum_{q=1}^{o} \tau_{it}^{q} \textit{Group}_{it}$$

$$\text{(5a)} \qquad \textit{Liability side Binary}_{it} = \alpha_t + \sum_{k=1}^{n} \beta_{it}^{k} \textit{Firm}_{it} + \sum_{p=1}^{n} \gamma_{it}^{p} \textit{MKT}_t$$

$$\text{(5b)} \qquad \textit{Liability side Binary}_{it} = \alpha_t + \sum_{k=1}^{n} \beta_{it}^{k} \textit{Firm}_{it} + \sum_{p=1}^{m} \gamma_{it}^{p} \textit{MKT}_t + \sum_{q=1}^{o} \tau_{it}^{q} \textit{Group}_{it}$$

$$\text{(6a)} \qquad \textit{Net exposure Binary}_{it} = \alpha_t + \sum_{k=1}^{n} \beta_{it}^{k} \textit{Firm}_{it} + \sum_{p=1}^{n} \gamma_{it}^{p} \textit{MKT}_t$$

$$\text{(6b)} \qquad \textit{Net exposure Binary}_{it} = \alpha_t + \sum_{k=1}^{n} \beta_{it}^{k} \textit{Firm}_{it} + \sum_{p=1}^{m} \gamma_{it}^{p} \textit{MKT}_t + \sum_{q=1}^{o} \tau_{it}^{q} \textit{Group}_{it}$$

We evaluate the relation on the overall time horizon and, by assuming 2007 as a threshold, in the two sub-periods before and during the crisis (2005-2007; 2008-2010) for testing the existence of any difference in the role of explaining variables during the financial crisis as supposed by the literature (i.a. European Central Bank, 2010b).

3.3 Variables definitions: theoretical assumptions, operational issues and research hypothesis

Group dynamics are defined like the actions, processes and interactions that occur within groups and between groups (Forsyth, 2009, p. 9). Such dynamics are affected by the interactions between the group members (Homans, 1950, p. 261) that are affected by the group structure (Cohen *et al.*, 1961), therefore the evolution of the corporate control structure of the group can be considered a proxy for the group dynamics.

Since groups are able to raise funds from internal markets to overcome liquidity shocks (Cetorelli and Goldberg, 2008), we consider the relevance of such liquidity sources by measuring the incidence of affiliates for which the commitment to transfer liquidity is higher because of the corporate control of the group with respect to the total subsidiaries. In the context of liquidity transfers inside the banking group, the level of correlation between cash flows can be affected by geographic origin (D'Souza and Lai, 2006), therefore we measure the geographic concentration of cash flows by introducing a variable constructed on the Herfindahl index of the affiliates classified according to the country of origin.

The liquidity risk of the group is affected by banks offering long-term assets and taking retail deposits (Kashyap *et al.*, 2002), so to take into consideration the relevance of the banking activity on controlled members of the group we introduce a variable based on the number of controlled bank subsidiaries divided by the total number of controlled subsidiaries. The contribution of bank affiliates to the liquidity strategy of the group can be affected by country-specific features, namely where banks operate due to differences in local markets and regulations on minimum liquidity reserve requirements, and on the support provided to affiliates by the group (Joint Forum, 2006). Accordingly, we take into consideration cross-border issues by introducing the variable Herfindahl index of the banks classified for the country of origin for each group.

In order to consider the difference in the business model adopted by different type of banking groups, we control the analyzed relationship for type, by distinguishing among groups that differ with regard to cooperative nature, public ownership, holding entity, size and risk. In fact to adjust liquidity when friction exists both in wholesale and retail markets (Freixas *et al.*, 2000), savings and cooperative banks create networks in which a head institution or more second-level institutions hold liquidity reserves and act to coordinate the reallocation of liquidity among the members (Mazzillis and Schena, 2001) to overcome the disadvantages in accessing liquidity caused by their limited size (Ehrmann and Worms, 2004). For this purpose, we introduce a dummy variable if the group has a cooperative nature. In addition to cooperative nature, the literature states that ownership type affects the recourse of groups to the interbank market (Cajueiro and Tabak, 2008). Consequently, we introduce the Public Owner variable to distinguish between private and publically owned groups. When the holding is a bank, liquidity management in the group is defined by a high level of centralisation (Joint Forum, 2006), which affects the access to external sources to satisfy liquidity shocks. Consequently, we implement a dummy variable that assumes a value of 1 if the holding is a bank, and 0 otherwise. Finally, creditworthiness affects access to the interbank market (Furfine, 2001) and can be proxied by credit rating. As under the contagion mechanism exposure represents the potential loss suffered by the financial system if the parent company is unable to recapitalise the affiliated entities, under the hypothesis of perfect dispersions of the exposures (Mistrulli, 2011) access to the interbank market is affected by the risk of the group. To measure the risk of the group we use the Support Rating provided by Fitch, based on the characteristics of the holding entity and other group members.

Following the literature as previously described, we consider the following target variables for banking group control structure:

$Controlled_{it}$: Number of controlled subsidiaries with respect to the number of total subsidiaries for group i in year t. Since groups are able to raise funds from internal markets to overcome liquidity shocks (Cetorelli and Goldberg, 2008), this variable serves as a proxy for the relevance of affiliates for which the commitment to transfer liquidity is higher because of the corporate control of the group.

$HH\ Overall_{it}$: Herfindahl index of the affiliates classified for the country of origin in year t for group i. The correlation between the cash flows of the group entities that work in the same country can affect the liquidity position of the group (D'Souza and Lai, 2006).

HH Banks$_{it}$: Herfindahl index of the banks classified for the country of origin in year *t* for group *i*. The contribution of bank affiliates to the liquidity strategy of the group can be affected by country-specific features where banks operate due to differences in local markets and regulations on minimum liquidity reserve requirements and on the support provided to affiliates by the group (Joint Forum, 2006).

Ratio Banks$_{it}$: Number of controlled bank subsidiaries divided by the total number of controlled subsidiaries. Because banks offer long-term assets and take retail deposits that affect liquidity risk (Kashyap *et al.*, 2002), the Ratio Banks variable serves as a proxy for the relevance of banking activity on controlled members of the group.

Cooperatives$_{it:}$ Dummy variable that assumes a value of 1 if the banking group is a cooperative banking group in year *t*. Banks can form relationship networks to adjust liquidity when friction exists both in the wholesale and retail markets (Freixas *et al.*, 2000) because they are more exposed to monetary policy shocks in their lending activities (Kashyap and Stein, 2000). As savings and cooperative banks belong to networks in which a head institution or more second-level institutions hold liquidity reserves and coordinate the reallocation of liquidity among the members (Mazzillis and Schena, 2001), they can overcome the disadvantages in accessing liquidity caused by their limited size (Ehrmann and Worms, 2004).

Public owner$_{it}$: Dummy variable that assumes a value of 1 if the owner of the group is public in year *t*. The analysis of public ownership is relevant because a public shareholder could normally affect the lending and investment policy of the banking group (Cajueiro and Tabak, 2008).

Holding Bank$_{it}$: Dummy variable that assumes a value of 1 if the owner of the group is a bank in year *t*. When the holding company is a bank, liquidity management is defined by a high level of centralisation (Joint Forum, 2006), which affects the access to external sources to satisfy liquidity shocks.

Rating$_{it}$: Support rating defined by Fitch that measures the quality of the banking groups based on the characteristics of the holding and the other group members that provides a judgment on a scale that varies from 1 (lowest-risk groups) to 6 (highest-risk groups) (Fitch, 2004).

In light of the previous theoretical assumptions supported by the existing literature, the following research hypothesis concerning group dynamics are tested:

Hypothesis 1: The degree of corporate control and geographical diversification of cash flows are relevant in explaining the banking groups' interbank exposures

Hypothesis 2: Bank group members are relevant in explaining banking groups' interbank exposures

To test the research hypotheses, we control for the relationship between the interbank market exposures and the banking group structure for the firm accounting features (Iyer and Peydró, 2011; Craig and Fecht, 2007), and market dynamics (Allen *et al.*, 2007).

For the firm accounting characteristics (Firm), we consider the following *n* items:

ROA$_{it}$: Return on Asset for group *i* at time *t*. The proxy measures the capability of the group to create in the long run, the internal financial resources necessary to meet liquidity needs (e.g., Flannery, 1981); as this variable concerns access to the interbank market,

ROA affects the price of interbank market borrowing because it signals the profitability of lender assets (Furfine, 2001).

$Size_{it}$: Natural logarithm of the market value of the group *i* at time *t*. It represents a proxy for the size of the group. Size influences the access to the interbank market for borrowers (Allen *et al.*, 1989), but because relationship borrowing among banks is negatively affected by size (Cocco *et al.*, 2009), the larger the group, the larger the amount of liquidity transfers internally released among related parties inside the group. Therefore, the correlation of cash flows among group members determines the liquidity needs/excess of the group (D'Souza and Lai, 2006).

NII_{it}: Non-Interest Income on Total Assets. Based on the contribution of investment bank activity to the profitability of the group, the variable serves as a proxy for the incidence of investment bank activity (European Central Bank, 2010a) because the focus on investment activity indicates a higher recourse to short-term collateralised borrowing than to the interbank market (Adrian and Shin, 2008).

RWA_{it}: Risk-weighted Assets on Assets for group *i* at time *t*. The variable measures risk-weighted assets according to the prudential regulation on capital requirements in force in the country where the holding of the group resides. It accounts for the risk of the group deriving from different sources, and among them, the risk of interbank loans (Rochet and Tirole, 1996).

$Lending_{it}$: Loans to customers on Total Assets for group *i* at time *t*. The variable represents the incidence of lending activity that determines the relevance of the investment in assets that can fail to provide liquidity when the firm needs it (Holmstroem and Tirole, 2000).

$Impaired\ loans_{it}$: Impaired Loans on gross Loans for group *i* at time *t*. The variable accounts for the quality of credit risk management with reference to the group (Casu and Girardone, 2004), and it affects the access to the interbank market, both in terms of price (Allen and Saunders, 1986) and amount (Cocco *et al.*, 2009).

$Fixed\ asset_{it}$: Fixed Assets on Total Assets for group *i* at time *t*. The variable accounts for the relevance of fixed assets and it therefore affects the opportunity to invest in the interbank market (Cyree *et al.*, 2000).

$Deposits_{it}$: Retail Deposits on Total Assets for group *i* at time *t*. Because liquidity risk depends primarily on retail deposits (Ho and Saunders, 1985), this variable accounts for the relevance of such deposits in financing assets.

$Securities_{it}$: Securities on Total Assets for group *i* at time *t*. The range of collateral affects the opportunity to raise liquidity through the interbank market (Fecht, Nyborg and Rocholl, 2011); subsequently, the Securities variable serves as a proxy for the collateral offered to satisfy liquidity needs.

For market dynamics (*MKT*), we consider the following *m* items:

$EONIA_t$: European Overnight Interest Average. The EONIA variable serves as a proxy for the cost and return involved in accessing the interbank market (Prati *et al.*, 2003).

$MargL_t$: Marginal lending facility volumes. This variable measures the amount of liquidity sources offered by the Central Bank that, because the Central Bank is normally the least expensive financing source, could negatively affect the number of transactions completed in the interbank market as an alternative liquidity market (Drehmann and Nikolaou, 2013).

Table 3: Summary statistics for dependent variables

	Obs	Mean	St.Dev.	Min	Max
Asset side	273	0.11	0.10	0.01	0.70
Liability side	278	0.13	0.09	0.00	0.46
Net exposure	278	0.02	0.10	–0.64	0.32
Asset Side – Binary	273	0.56	0.50	0.00	1.00
Liability Side – Binary	278	0.45	0.50	0.00	1.00
Net exposure – Binary	278	0.67	0.47	0.00	1.00

Source: Bankscope data processed by the authors.

Table 4: Summary statistics for independent variables

	Code	Obs	Mean	St.Dev.	Min	Max
ROA	(1)	280	0.00	0.01	–0.06	0.04
Size	(2)	278	12.74	1.13	10.7	15.08
NII	(3)	278	0.73	0.84	–1.11	7.03
RWA	(4)	273	0.52	0.23	0.14	1.00
Lending	(5)	278	0.53	0.20	0.00	0.80
Impaired loans	(6)	278	0.03	0.03	0.00	0.13
Fixed assets	(7)	280	0.01	0.01	0.00	0.04
Deposits	(8)	280	0.36	0.28	0.00	1.00
Securities	(9)	278	0.63	0.30	0.08	1.00
EONIA	(10)	300	0.02	0.01	0.00	0.04
MargL	(11)	300	20.80	23.80	0.05	53.20
Controlled	(12)	300	0.35	0.25	0.00	1.00
HH Overall	(13)	300	0.47	0.28	0.05	1.00
HH Banks	(14)	300	0.43	0.32	0.05	1.00
Ratio Banks	(15)	300	0.18	0.14	0.01	0.63
Cooperatives	(16)	300	0.10	0.30	0.00	1.00
Public Owner	(17)	300	0.14	0.35	0.00	1.00
Holding Bank	(18)	300	0.74	0.44	0.00	1.00
Rating	(19)	300	1.56	1.07	1.00	5.00

Source: Bankscope data processed by the authors.

A summary table (Table 1.A) with the description of all the variables and the expected relationships with the interbank market exposures is provided in the Annex.

3.4 Summary statistics and correlation analysis

The proxies for the interbank exposure for the banking groups are summarised in the table below (Table 3).

On average the exposure on the asset side is lower with respect to the liability side (respectively 0.11 and 0.13) but the range of variation is higher for the former with respect to the latter (range of variation of 0,69 and 0.46 respectively). The average net exposure is on average positive but there is a significantly higher exposure on the asset side with respect to the liability side in the sample banks (the minimum net exposure is equal to –0.64). The analysis of the binary variables shows that the average values previously described for the asset and liability sides are driven by the existence of outliers. In 56% of cases asset side exposures are higher than the mean while in only 45% of cases the liability side exposure is higher than the average.

The analysis of the independent variables describes some characteristics of the sample considered with respect to market features (Table 4).

Some of the group dummy variables considered are invariant over the time horizon considered for each financial groups (such as Holding bank, Cooperative and Public) and so the inclusion of these variables implies the choice of the random effects regression models[1]. A preliminary analysis of multi-collinearity issues is shown in the pairwise correlation table among variables (Table 5) and results obtained do not show a clear multicollinearity bias.

3.5 Results

To test the different roles of the banking group features on interbank exposure, we perform a panel linear regression with random effects of the asset, liability and net exposure for all the groups considered (Table 6).

The choice to include control structure features of the banking group increases the overall R^2 of the regression model. Therefore, to explain the recourse to the interbank market of the main banking groups, it is necessary to explicitly consider the control structure of the banking group. The analysis of the asset side of interbank exposure is normally easier to model, while the analysis of the liability side and the net exposure is less explainable.

Among the accounting characteristics banking group features, the performance measure (measured by ROA) negatively affects interbank exposure. For the liability side, the negative effect can be explained by the low dependence of the group with respect to the rest of the market because of the opportunity for self-financing. For the asset side, the relationship is negative because of the low profitability of the interbank lending with respect to the other investment opportunities, which implies that these types of investments are less relevant with respect to other investment opportunities (Wong, 1997). Looking at the results for the pre-crisis and the post crisis period, the significance of the index for the overall period can be ascribed prevalently to the post-crisis period for both liability and net exposure.

Normally, larger groups are less active in interbank markets because of the opportunities that they have to use internally generated financial resources to meet liquidity needs. This relation is clear on the asset side, while for the liability side there is no clear statistical relationship. The lack of relevance for the liability side could be explained by the existence of a residual (and marginal) financing policy in the interbank market for the larger groups that exist to meet unexpected liquidity needs. The relevance of size on net exposure can imply potential systemic effects of interbank market activity.

The investments released in the interbank market are negatively affected by the relevance of lending activity because the bank is more worried about creating the reserves necessary to address unexpected losses related to lending exposures. For net exposure, results are driven by the asset side and they are statistically significant especially before the crisis.

[1] The Hausman specification test confirms that the choice is also statistically reasonable on the basis of the sample characteristics. Results of the test are not presented in the article but are available upon request.

Table 5: Correlation analysis for independent variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1)	1.00																		
(2)	−0.14	1.00																	
(3)	0.13	0.16	1.00																
(4)	0.37	−0.31	−0.06	1.00															
(5)	0.38	−0.23	−0.21	0.27	1.00														
(6)	−0.16	0.05	−0.04	0.04	0.04	1.00													
(7)	−0.19	−0.28	−0.10	0.28	0.19	0.14	1.00												
(8)	−0.36	−0.05	0.16	−0.02	−0.04	0.06	0.27	1.00											
(9)	−0.26	0.31	0.29	−0.29	−0.30	0.06	−0.20	−0.07	1.00										
(10)	0.19	−0.04	0.06	0.07	0.04	−0.32	−0.01	−0.09	−0.03	1.00									
(11)	−0.26	0.07	−0.19	−0.14	−0.05	0.09	−0.02	0.05	0.01	0.24	1.00								
(12)	−0.06	0.32	0.13	−0.16	−0.09	0.06	−0.01	−0.08	0.32	−0.01	−0.02	1.00							
(13)	−0.06	−0.27	0.21	0.09	0.02	0.02	−0.02	−0.07	−0.25	0.03	0.04	−0.24	1.00						
(14)	−0.02	−0.25	0.21	0.07	0.08	−0.06	0.17	0.08	−0.27	0.04	0.02	−0.23	0.32	1.00					
(15)	0.08	0.02	0.06	−0.06	0.13	0.06	0.11	0.03	−0.03	0.00	−0.27	0.24	−0.23	−0.22	1.00				
(16)	0.10	−0.12	−0.02	0.20	0.08	−0.10	0.29	0.03	−0.14	0.02	0.01	−0.09	0.30	0.27	−0.24	1.00			
(17)	−0.12	−0.22	0.01	−0.30	−0.27	−0.25	−0.30	−0.23	0.11	0.08	0.04	−0.16	0.33	0.17	−0.16	−0.13	1.00		
(18)	−0.11	0.09	0.07	0.01	−0.06	−0.25	−0.16	0.04	0.02	0.00	0.23	0.03	0.02	−0.10	−0.31	−0.07	0.10	1.00	
(19)	0.16	−0.18	−0.05	0.22	0.21	0.09	0.26	0.06	−0.17	0.02	−0.01	−0.20	0.10	0.17	0.07	0.08	−0.21	−0.31	1.00

Notes: ROA = (1); Size = (2); NII = (3); RWA = (4); Lending = (5); Impaired loans = (6); Fixed assets = (7); Deposits = (8); Securities = (9); EONIA = (10); MargL = (11); Controlled = (12); HH Overall = (13); HH Banks = (14); Ratio Banks = (15); Cooperatives = (16); Public Owner = (17); Holding Bank = (18); Rating = (19).

Source: Bankscope data processed by the authors.

Table 6: Liquidity risk exposure determinants – OLS panel random effect regression

	(1a)			(1b)			(2a)			(2b)			(3a)			(3b)		
	All	BC	PC	All	BC	PC	All	BC	PC	All	BC	PC	All	BC	PC	All	BC	PC
ROA	−0.68*	−0.30	−0.19	−0.37	0.11	−0.01	−2.00**	−1.89*	−2.93**	−1.90**	−0.88	−2.72**	−1.35**	−1.74	−2.42**	−1.55**	−1.61	−2.43**
Size	−0.03**	−0.03**	−0.02**	−0.01*	−0.01	0.00	−0.01	−0.01	0.00	−0.01	0.00	0.00	0.02**	0.01	0.02**	0.00	0.00	0.00
NII	0.00	0.00	−0.01*	0.00	0.00	−0.01*	0.00	−0.01	0.02*	0.00	−0.01	0.02*	0.00	−0.01*	0.03**	0.00	−0.01*	0.03**
RWA	−0.01	−0.04*	−0.02	0.00	−0.03	−0.02	0.00	−0.06*	−0.02	0.01	−0.02	−0.01	0.01	−0.02	0.02	0.01	−0.01	0.02
Lending	−0.16**	−0.48**	−0.08**	−0.11**	−0.38**	−0.06**	−0.05	−0.08	−0.07*	−0.01	0.08	−0.03	0.09**	0.37**	0.05	0.08*	0.42**	0.04
Impaired loans	−0.69**	−0.16	−0.48**	−0.54**	−0.07	−0.32*	−0.53**	−0.21	0.00	−0.41*	0.21	0.19	0.15	−0.14	0.66**	0.13	−0.01	0.63*
Fixed assets	−1.53*	−1.55*	−0.37	−0.25	−1.21	0.43	0.57	−1.31	−1.75	1.16	−0.66	−1.14	2.23*	0.14	−0.75	1.63	0.50	−1.26
Deposits	0.00	−0.28**	−0.04	−0.01	−0.24**	−0.02	−0.08**	−0.11	−0.04	−0.07**	0.03	−0.02	−0.08**	0.19*	0.00	−0.07**	0.29*	0.00
Securities	−0.07**	−0.21**	−0.06**	−0.08**	−0.20**	−0.06**	0.00	−0.03	−0.08**	0.02	0.02	−0.06*	0.08**	0.17**	−0.03	0.11**	0.20**	0.01
EONIA	−0.33	−1.46**	0.53	−0.30	−1.44**	0.59	0.18	−1.71*	1.29*	0.17	−1.33	1.21*	0.51*	−0.33	0.77	0.49*	−0.07	0.67
MargL	0.98**	0.22	−2.13	1.00**	0.19	−2.09	0.95**	0.75	−0.77	0.97**	0.55	−0.18	−0.08	0.53	1.38	−0.11	0.48	1.73
Controlled				−0.01	−0.04	−0.01				0.03**	−0.01	0.02				0.04**	0.01	0.03*
HH Overall				0.02	0.02	0.05				−0.04	−0.08	0.02				−0.06	−0.11	−0.04
HH Banks				0.01	−0.04	−0.01				0.02	0.04	−0.06				0.02	0.07	−0.06
Ratio Banks				0.12**	0.06	0.11*				0.07	0.01	0.01				−0.02	0.00	−0.09
Cooperatives				−0.04	0.03	−0.04				−0.06*	−0.04	−0.02				−0.03	−0.06	0.02
Public Owner				0.16**	0.13**	0.16**				0.10**	0.16**	0.10**				−0.07*	0.01	−0.05
Holding Bank				0.02	−0.03	0.03				0.01	0.01	−0.01				0.00	0.05	−0.03
Rating				−0.01**	0.00	0.00				−0.01*	−0.02*	0.00				0.00	−0.02	0.00
Constant	0.63**	1.01**	0.55**	0.34**	0.79**	0.22*	0.27**	0.50**	0.22*	0.19	0.23	0.17	−0.35**	−0.45**	−0.35**	−0.10	−0.44*	−0.02
Observations	273	130	143	273	130	143	273	130	143	273	130	143	273	130	143	273	130	143
Groups	49	47	49	49	47	49	49	47	49	49	47	49	49	47	49	49	47	49
Adj. R^2 overall	0.40	0.72	0.28	0.64	0.83	0.60	0.17	0.23	0.30	0.39	0.56	0.49	0.07	0.34	0.20	0.15	0.49	0.40

Panels 1a and 1b use as explained variable the overall investment released by a banking group in the lending activity on the interbank market, panels 2a and 2b consider all the deposits obtained by other banks while panels 3a and 3b study the difference between the liability and the asset side exposure. In the analysis we consider the overall time period (All), the pre-crisis (BC) and the post crisis (PC).
The set of explanatory variables includes group performance and risk exposure (ROA, size, NIC/TA, RWA, Lending, Impaired loans, Fixed assets, Deposits and Securities), interbank market dynamics (EONIA and Deposit facility), group features (Controlled, HH Overall), HH Banks, Ratio Banks, Cooperative, Public, Holding Bank and Rating). For further details and summary statistics see Section 3.2.

Notes: *** Statistical significant at 1% level, ** Statistical significant at 5% level, * Statistical significant at 10% level.

Source: Bankscope data processed by the authors.

Impaired loans negatively affects interbank activity (both on the asset and liability sides) because of the lower reputation of the banking groups in the market when the number of defaults increases (Allen and Saunders, 1986). Looking at the crisis period these assets are statistically relevant only for the asset side because due to the low return of the interbank market investment banks more affected by defaults have to reduce their exposure.

The amount of fixed assets negatively affects the interbank investments because banks that are more exposed to long-term investments have a higher need for money to support growth and invest less in the interbank market – especially in the pre-crisis period (Cyree *et al.*, 2000). When including group control structure variables, the fixed assets investment variables lose their statistical significance.

The amount of deposits negatively affects group activity in the interbank market, as financial flows collected through deposits negatively affect the need for interbank funding to overcome liquidity needs. The variable is statistically relevant for the liability side and the net exposure, and it is driven by the asset side because of the high relevance of deposit funding in substituting interbank liabilities as the availability of deposits reduces the liquidity risk of the bank determined by the extension of loan commitments (Gatev *et al.*, 2009). If we consider separately the pre-crisis and post crisis period, the variable is relevant only before the crisis for both asset and net exposure.

The availability of securities negatively and significantly affects investment exposure, while an opposite impact is observed for the net exposure on the interbank market. The results for the net exposure are driven by the asset side, as the investment in securities affects the allocation of financial sources into different types of assets. During the post crisis period, the groups show a movement toward collateralized borrowing over the interbank market (Adrian and Shin, 2008) – this is not considered in this study.

The EONIA interest rate seems to significantly affect both the asset and liability sides of the banking group's exposure in the interbank market. The relationship is not consistent with the literature and is not verified when the financial crisis dummy variable is considered. The relationship identified is not related to market dynamics; it is only affected by the change in the EONIA market trend during the crisis (Brunnemeier, 2009).

The amount of credit offered to the financial system positively affects interbank activity because, normally, the higher the amount offered by the Central Bank, the higher the amount of funds that can be lent among banking groups. Due to the decrease of transactions and changes in the structure of lending among banks featuring in the financial crisis (Hale, 2012), the relationship is verified only for the before crisis period.

Considering corporate control structure, the scope of control, the type of group (public or private) and the rating are found to affect liquidity exposure.

The higher the number of controlled entities in the group, the higher the amount of interbank debt. The effect on net exposure is clearer and statistically significant, and is driven by the asset side, even though this is not significant. These empirical findings can be explained in light of highly centralised group liquidity management that favor investments primarily in intragroup lending instead of interbank investments (Cetorelli and Goldberg, 2008) with a positive effect on system stability due to the higher degree of homogeneity among the affiliated entities (Iori *et al.*, 2006).

Group banking activity positively affects investment in the interbank market, while results are not significant for the liability side and the net exposure. Moreover, the significance of the relationship is driven by the post crisis period: this evidence can be explained in light of the attitude to raise funds through retail markets and the impact of the refinancing operations promoted by the ECB (Eisenschmidt *et al.*, 2009). Lastly, the evidence shows that banks have lended to each other in the post crisis period, showing that freezing of the interbank market during the crisis (Upper, 2006) period has been overcome.

Normally, publicly owned banking groups utilise interbank lending however the net exposure in the interbank market is found to be not clearly affected by public ownership. During the crisis, they do not invest in the interbank sector because, the Government agrees to provide the amount of capital necessary only if the banking group significantly modifies (reduces) its risk exposure (Cajueiro and Tabak, 2008).

Usually, less risky banking groups (lower ratings assigned by Fitch) have a lower exposure in the interbank market, and they are also able to increase the lending obtained in the interbank market because of the high reputation they have in the credit market. The significance of the rating is not observed only for the net effect, as the relevance of the asset side and the liability side are comparable. Focusing on the asset side, investments in the interbank market by banking groups decrease with the increase of risk. This suggests that the relevance of the risk transformation function played by interbank markets among counterparties of different creditworthiness (Dematté, 1981). On the liability side, riskier groups access interbank market liabilities to a lower extent, coherently with the monitoring and screening activity performed by counterparties (Furfine, 2001). Although the rating is found to be significant for interbank transactions at bank level after the financial crisis in previous studies (e.g. Angelini *et al.*, 2011), the insignificance showed in this study can be attributed to the changes in the group dynamics post crisis.

Examining the binary variables constructed on the asset side, liability side and net exposure exhibit some interesting differences with respect to exposure amount (Table 7).

Logit regression models perform worse with respect to the ordinary least squares models when only the asset side or the liability side are considered. Only when we consider the overall time horizon and analyze the role of group variable in explaining net exposure do the logit regressions fit better with the data.

In terms of the explanatory variables, the choice of the logit regression models modifies the statistical performance of some firm specific and market explanatory variables: there is no change in the sign of almost all relationships identified but the statistical relevance is found to be different.

More interesting differences are seen regarding the group features that explain the status of net lender in the interbank market. During the overall period, banking groups with a net negative exposure are normally those in which the number of banks from the same country is higher (HH banks is higher), the bank is not a cooperative one and where the percentage of controlled entities is positive for the overall timeframe. Geographical concentration can positively affect cash flow correlation (D'Souza and Lai, 2006). The cooperative bank status may affect the probability of being a debtor in the interbank market because (on average) this type of bank is normally smaller, so their access to the

Table 7: Liquidity risk exposure determinants – Logit panel regression random effect

Equation	(4a)			(4b)			(5a)			(5b)			(6a)			(6b)		
Time horizon	All	BC	PC	All	BC	PC	All	BC	PC	All	BC	PC	All	BC	PC	All	BC	PC
ROA	−4.98	0.87	−4.76	−4.14	2.37	−3.81	−4.17	2.18	−10.47**	−3.24	5.10	−8.55*	−0.61	−7.24	−2.40	−1.20	−2.18	−3.33**
Size	−0.04	0.03	−0.04	−0.01	0.11	0.01	0.01	−0.03	0.01	−0.01	−0.03	−0.02	0.10*	0.05	0.10*	0.10*	0.04	0.08
NII	−0.04	−0.04	−0.01	−0.04	0.00	−0.03	−0.02	−0.01	0.00	−0.01	−0.02	0.00	0.00	−0.06	0.03	0.00	−0.07	0.04
RWA	0.01	0.28	−0.20	0.06	0.34	−0.17	0.00	−0.24	−0.07	0.06	−0.12	−0.03	0.11	0.08	−0.06	0.18	0.25	0.08
Lending	−0.87**	−1.26**	−0.63*	−0.77**	−0.78	−0.56*	−0.26	0.02	−0.26	−0.09	0.42	−0.08	0.50*	0.56	0.33	0.79**	0.91*	0.46
Impaired loans	−4.32**	2.45	−4.40*	−3.90**	2.85	−3.40	−2.98**	−0.52	−2.88	−2.30*	0.95	−2.17	0.41	−0.44	1.62	0.65	0.51	1.70*
Fixed assets	−14.24*	−20.46*	−6.82	−10.14	−27.46**	−0.61	−3.62	−12.16*	−21.46*	0.57	−8.79	−15.18	0.16	−1.12	−6.70	3.54	11.36	−2.10**
Deposits	0.04	−0.82	−0.09	−0.05	−2.09**	−0.09	−0.21	−0.38	0.02	−0.16	0.19	0.10	−0.04	0.85	0.17	0.04	1.88**	0.05
Securities	−0.53**	−0.61*	−0.38*	−0.64**	−0.75**	−0.59*	−0.01	0.11	−0.24	0.13	0.15	−0.01	0.18	0.51*	−0.23	0.39*	0.85**	0.02
EONIA	2.32	−6.85	14.59*	2.67	−8.44	16.25**	0.29	−9.43**	−2.32	0.53	−7.93*	−3.91	1.07	−1.01	0.97	0.62	2.65	−0.26**
MargL	−1.93	0.98	−45.43*	−2.15	−0.12	−49.41*	−0.49	5.22	15.90	−0.68	4.35	21.72	−0.39	3.17	5.72	−0.16	2.58	9.03**
Controlled				−0.13	0.34	−0.14				0.21**	−0.29	0.21**				0.26**	−0.16	0.18
HH Overall				−0.01	0.18	0.03				0.01	−0.30	0.27				−0.26	−0.38	−0.28
HH Banks				−0.14	−0.26	−0.15				−0.08	0.13	−0.32				0.48*	0.76**	0.33
Ratio Banks				0.38	0.08	0.85*				−0.09	−0.52	−0.03				−0.15	−0.40	0.03
Cooperatives				−0.14	0.02	−0.13				−0.41*	−0.27	−0.27				−0.53**	−0.78**	−0.33
Public Owner				0.30	0.14	0.40*				0.26	0.51*	0.22				0.05	0.18	0.03
Holding Bank				−0.08	−0.49**	0.08				0.05	−0.06	0.10				0.06	0.35*	−0.08
Rating				−0.04	0.09	−0.04				−0.09**	−0.15*	−0.02				−0.04	−0.20**	−0.08
Constant	2.03**	1.69*	2.72**	1.79*	1.04	2.03*	0.61	1.08	0.56	0.77	1.08	0.25	−1.10*	−0.90	−0.81	−1.53*	−1.78*	−0.75
Observations	273	130	143	273	130	143	273	130	143	273	130	143	273	130	143	273	130	143
Groups	49	47	49	49	47	49	49	47	49	49	47	49	49	47	49	49	47	49
Adj. R^2 overall	0.15	0.27	0.17	0.22	0.43	0.33	0.10	0.20	0.23	0.24	0.42	0.33	0.08	0.11	0.10	0.26	0.50	0.21

All the panels use as a dummy dependent variable. For panels 4a) and 4b) it is 1 if the asset side exposure is higher that median value; for panels 5a) and 5b) it is 1 if the liability side exposure is higher than the median value. For panels 6a) and 6b) it is 1 if the liability side is higher than the asset side exposure. In the analysis we consider the overall time period (All), the pre-crisis (BC) and the post crisis (PC). The set of explanatory variables includes group performance and risk exposure (ROA, size, NIC/TA, RWA, Lending, Impaired loans, Fixed assets, Deposits and Securities), interbank market dynamics (EONIA and Deposit facility), group features (Controlled, HH Overall), HH Banks, Ratio Banks, Cooperative, Public, Holding Bank and Rating). For further details and summary statistics see Section 3.2.

Notes: *** Statistical significant at 1% level, ** Statistical significant at 5% level, * Statistical significant at 10% level.

Source: Bankscope data processed by the authors.

Table 8: Liquidity risk exposure determinants rescaled by the size – OLS and Logit panel regression random effect

Equation	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)	(6a)	(6b)
ROA	−0.06*	−0.05	−0.01***	−0.01**	−0.04	−0.07	−4.98	−4.14	−4.17	−3.24	−0.61	−1.20
Size	−0.06**	−0.04***	−0.05***	−0.05***	−0.05	−0.01	−0.04	−0.01	0.01	−0.01	0.10*	0.10*
NII	0.02	0.02	0.03	0.03	−0.01	−0.03	−0.04	−0.04	−0.02	−0.01	0.00	0.00
RWA	−0.02	−0.08	0.04	0.02	0.03	0.02	0.01	0.06	0.00	0.06	0.11	0.18
Lending	−0.01***	−0.06	−0.03	−0.01	0.06*	0.05	−0.87**	−0.77**	−0.26	−0.09	0.50*	0.79**
Impaired loans	−0.04**	−0.03	−0.04**	−0.04**	0.02	−0.05	−4.32**	−3.90**	−2.98**	−2.30*	0.41	0.65
Fixed assets	−0.02	−0.05***	0.01**	0.03***	0.03***	0.02***	−14.24*	−10.14	−3.62	0.57	0.16	3.54
Deposits	−0.02	−0.03*	−0.08***	−0.08***	−0.07***	−0.07***	0.04	−0.05	−0.21	−0.16	−0.04	0.04
Securities	−0.03*	−0.04***	0.03	0.03	0.06*	0.08***	−0.53**	−0.64**	−0.01	0.13	0.18	0.39*
EONIA	−0.02	−0.03*	−0.02	0.02	0.01	0.01	2.32	2.67	0.29	0.53	1.07	0.62
MargL	0.06***	0.07***	0.04	0.04	−0.03	−0.03	−1.93	−2.15	−0.49	−0.68	−0.39	−0.16
Controlled		−0.02***		0.03		0.03**		−0.13		0.21**		0.26**
HH Overall		−0.02		−0.08*		−0.07		−0.01		0.01		−0.26
HH Banks		0.06**		0.06*		0.02		−0.14		−0.08		0.48*
Ratio Banks		0.02***		0.01**		0.03		0.38		−0.09		−0.15
Cooperatives		−0.03		−0.06**		−0.04		−0.14		−0.41*		−0.53**
Public Owner		0.01***		0.06**		−0.10**		0.30		0.26		0.05
Holding Bank		0.03		−0.03		−0.02		−0.08		0.05		0.06
Rating		−0.09		0.06		−0.04		−0.04		−0.09**		−0.04
Constant	0.09***	0.06***	0.07***	0.07***	−0.01	0.01	2.03**	1.79*	0.61	0.77	−1.10*	−1.53*
Observations	273	273	273	273	273	273	273	273	273	273	273	273
Groups	49	49	49	49	49	49	49	49	49	49	49	49
Adj. R^2 overall	0.41	0.56	0.41	0.50	0.06	0.12	0.15	0.22	0.10	0.24	0.08	0.26

Equation from 1a to 6b are coherent with those used for table 6 and 7 but all dependent variables are computed as a relative index with respect to total assets.
In the analysis we consider only the overall time period (All) but results for the pre-crisis (BC) and the post crisis (PC) are consistent.
The set of explanatory variables includes group performance and risk exposure (ROA, size, NIC/TA, RWA, Lending, Impaired loans, Fixed assets, Deposits and Securities), interbank market dynamics (EONIA and Deposit facility), group features (Controlled, HH Overall), HH Banks, Ratio Banks, Cooperative, Public, Holding Bank and Rating). For further details and summary statistics see Section 3.2.

Notes: *** Statistical significant at 1% level, ** Statistical significant at 5% level, * Statistical significant at 10% level.

Source: Bankscope data processed by the authors.

interbank market to satisfy liquidity needs is lower (Allen *et al.*, 1989). Normally the higher number of controlled banks, the higher the commitment to collect money to overcome their liquidity need from the interbank market is (Cetorelli and Goldberg, 2008). Subsequently, a high commitment to serve these affiliates could cause a net debtor exposure for the banking group (Table 7).

If we distinguish between the pre-crisis and the post-crisis period, in the latter group features do not allow us to distinguish between net debtors and net creditors while in the pre-crisis period, other group features (like the status of bank for the ultimate owner and the rating) are statistically significant. The lower relevance of group features in explaining interbank exposure during the crisis is consistent with the US experience where the sensitivity of interbank exposure to bank specific features (Angelini *et al.*, 2011) and riskiness significantly increased (Afonso *et al.*, 2011).

3.6 Robustness test

The literature demonstrates that small and big banks behave differently in the interbank market and the differences are consistent independently with respect to the market considered (Dinger and Von Hagen, 2009). We perform a robustness test of the results obtained considering a new set of liquidity exposure proxies consistent with the previous analysis (formulas 1 to 6) but rescaled for the total assets of the bank (Table 8).

Results of the OLS analysis are not significantly affected by the choice between the gross value or the relative value with respect to total assets, and the fitness of the model is higher for the analysis of the interbank lending exposure. The main difference among results achieved is the lower relevance of the group's rating in the analyses based on the relative exposure to total assets with respect to the analyses based on gross amounts.

The analysis of the logistic model performs exactly the same because the differences in the firms classified as above the median value are not relevant independently with respect to the choice of classifying banks on the basis of the gross exposure or the relative exposure with respect to total assets.

4. Conclusions

Consistent with other studies available within the literature there are some bank features (such as lending and size) and some market trends (interest rate and credit supply) that can affect the interbank activity of banking groups. Banking group features significantly affect the exposure in the interbank market of the overall banking group for both the asset and liability sides. The type of group, the degree of control and the rating of the group are the most important variables for explaining interbank exposure, but during the financial crisis, the role of these features in explaining the groups' interbank market exposure decreased significantly.

The role of banking features in explaining the liquidity exposure of the overall banking group demonstrates the need for a supervisory approach that examines the banking

group's exposure as a whole instead of analysing each bank's exposure. The results support the theory proposed by several authors about the effects of a centralised banking supervision process (e.g., Rochet and Tirole, 1996) on the main European banking groups made directly by the ECB or by a macroprudential supervisory authority.

The relevance of banking group variables in explaining interbank market exposure demonstrates the need for a supervisory approach on liquidity market dynamics that uses a macro scenario to evaluate intragroup bank transfers. The attention given by the regulator to geographic diversification is not sufficient in order to supervise multinational financial groups due to problems related to national law differences.

One of the key features of European banking groups is the co-existence of groups headed by bank holdings and other types of holdings (Dierick, 2004). Empirical evidence demonstrates that those that led by a bank before the crisis tended to be more exposed net lenders in the market. The support provided by these groups to interbank liquidity can lead the supervisor to support their development instead of the growth of financial groups that are led by other banking institutions.

A subsequent research step will be to refine some of the explanatory variables (such as the HH) to verify whether a change in index specification can affect the statistical fitness of the model and variable significance. To measure how much group features affect liquidity exposure, an event study approach could possibly identify how the different changes in group features could affect the interbank exposure of the banking group.

The current debate about the SFI demonstrates the attention given by supervisors to monitoring the largest European financial groups to mitigate the risk of a future financial crisis (e.g., Masera, 2009). Evidence presented in this article demonstrates the role of a number of group features in explaining interbank exposure and they could be useful in the definition of the new supervisory guidelines for liquidity management. The current regulatory framework highlights the relevance of liquidity risk measurement at group level and points out some legal constraints that have to be considered for evaluating liquidity transfer restrictions (BIS, 2010). Nonetheless, empirical evidence presented in this article demonstrates the relevance of features like degree of control, ownership, number of banks in the group and group rating for the main European bank groups, and the findings point out some further development opportunities for the current regulatory framework.

Aknowledgement

The article is the result of the authors' common efforts and continuous exchange of ideas. Authors are grateful to the two anonymous referees and EFMA 2012 delegates for all the useful suggestions provided for improving the previous versions of the paper. The individual parts of the article can be acknowledged as follows: the introduction, literature review and conclusion were worked out by Lucia Gibilaro, empirical analysis by Gianluca Mattarocci.

Annex

Table 1.A: Variables description

Name	Description	Classification	Relevant literature	Expected Sign		
				Asset side	Liability side	Net exposure
Asset side	Loans and Advances to Banks	Dependent variable	Cocco, Gomes, and Martins, 2009	/	/	/
Liability side	Deposits from Banks	Dependent variable	Cajueiro and Tabak, 2008	/	/	/
Net exposure	Difference between Deposits from Banks and Loans and Advances to Banks	Dependent variable	Wong, 1997 Demattè, 1981	/	/	/
Controlled	Number of controlled subsidiaries with respect to the number of total subsidiaries for the group	Target variable – Banking group control structure		+/–	+/–	+/–
HH Overall	Herfindhal index of the alliliates classified for the country of origin	Target variable – Banking group control structure		+/–	–	+/–
HH banks	Herfindhal index of the banks classified for the country of origin	Target variable – Banking group control structure		+/–	+/–	+/–
Ratio Banks	Number of controlled bank subsidiaries divided by the total number of controlled subsidiaries	Target variable – Banking group control structure		+/–	+/–	+/–
Cooperatives	Dummy variable that assumes a value of 1 if the banking group is a cooperative banking group	Target variable – Banking group control structure		–	–	–
Public owner	Dummy variable that assumes 1 if the owner of the group is public	Target variable – Banking group control structure		+	+/–	+/–
Holding bank	Dummy variable the assumes a value of 1 if the owner of the group is a bank	Target variable – Banking group control structure		–	–/+	–/+
Rating	Support rating defined by Fitch that measures the quality of the banking groups based on the characteristics of the holding and the other group memebers that provides a judgnebt on a scale that varies from 1 to 6	Target variable – Banking group control structure		–	–	–
ROA	Return on Asset for group	Control variable – Firm accounting features	Flannery, 1981 Furfine, 1981	–	+/–	+/–

Table 1.A: (Follows)

Name	Description	Classification	Relevant literature	Expected Sign		
Size	Natural logarithm of the market value of the group	Control variable – Firm accounting features	Allen, Peristiani and Saunders, 1989 Cocco, Gomes, and Martins, 2009 D'Souza and Lai, 2006	–	–	+/–
NII	Not Interest Income on Total Assets	Control variable – Firm accounting features	Adian and Shin, 2008	+/–	–	+/–
RWA	Risk–weighted Assets on Assets for the group	Control variable – Firm accounting features	Rochet and Tirole, 1996	–	+	+/–
Lending	Loans to customers on Toatal Assets for the group	Control variable – Firm accounting features	Holmstroem and Tirole, 2000	–	+	+/–
Impaired loans	Impaired Loans on gross Loans for the group	Control variable – Firm accounting features	Casu and Girardone, 2004 Allen and Saunders, 1986 Cocco, Gomes, and Martins, 2009	–	–	–
Fixed asset	Fixed Assets on Total Assets for the group	Control variable – Firm accounting features	Cyree, Wansley and Boehn, 2000	–/+	+/–	+/–
Deposits	Retail Deposits on Total Assets for the group	Control variable – Firm accounting features	Ho and Saunders, 1985	+	–	+/–
Securities	Securities on Total Assets for the group	Control variable – Firm accounting features	Fecht, Nyborg and Rocholl, 2011	–	+	+/–
EONIA	EONIA Overnight Interest Average	Control variable – Market dynamics	Prati, Bartolini and Bertola, 2003	+	–	+/–
MarL	Marginal lending facility volume	Control variable – Market dynamics	Drehmann and Nikolaou, 2013	+	+	+

References

Adrian T. and Shin H.S. (2008) 'Liquidity, Monetary Policy, and Financial Cycles', *Current Issues in Economics and Finance*, XXIV, pp. 1-7.

Affinito M. (2012) 'Do Interbank Customer Relationships Exist? And how Did They Function in the Crisis? Learning from Italy', *Journal of Banking & Finance*, XXXVI, pp. 3163-3184.

Afonso G., Kovner A. and Schoar A. (2011) 'Stressed, not Frozen: The Federal Funds Market in the Financial Crisis', *Journal of Finance*, LXVI, pp. 1109-1139.

Allen F., Carletti E. and Gale D. (2009) 'Interbank Market Liquidity and Central Bank Intervention', *Journal of Monetary Economics*, LVI, pp. 639-652.

Allen F. and Gale D. (2000) 'Financial Contagion', *Journal of Political Economy*, CVIII, pp. 1-33.

Allen L., Peristiani S. and Saunders A. (1989) 'Bank Size, Collateral, and Net Purchase Behavior in the Federal Funds Market: Empirical Evidence', *Journal of Business*, LXII, pp. 501-515.

Allen L. and Saunders A. (1986) 'The Large-Small Bank Dichotomy in the Federal Funds Market', *Journal of Banking & Finance*, X, pp. 219-230.

Altunbas Y. and Molyneux P. (1996) 'Economies of Scale and Scope in European Banking', *Applied Financial Economics*, 6, pp. 367-375.

Angelini P., Nobili A. and Picillo C. (2011) 'The Interbank Market after August 2007: What Has Changed, and Why?', *Journal of Money,Credit and Banking*, XLIII, pp. 923-958.

Babetskaia-Kukharchuk O., Babetskii I. and Podpiera J. (2008) 'Convergence in Exchange Rates: Market's View on CE-4 Joining EMU', *Applied Economics Letters*, XV, pp. 385-390.

Baele L., Ferrando A., Hoerdhal P., Krylova E. and Monnet C. (2004) 'Measuring European Financial Integration', *Oxford Review of Economic Policy*, XX, pp. 509-530.

Bangia A., Diebold F.X., Schuermann T. and Stroughair J.D. (1999) 'Modeling Liquidity Risk, with Implications for Traditional Market Risk Measurement and Management', http://fic.wharton.upenn.edu/fic/articles/99/9906.pdf.

Bartram S.M., Taylor S.J. and Wang Y.H. (2007) 'The Euro and European Financial Market Integration', *Journal of Banking and Finance*, XXXI, pp. 1461-1481.

Berger A.N. and Bouwman C.H.S. (2009) 'Bank Liquidity Creation', *Review of Financial Studies*, XXII, pp. 3379-3837.

BIS (2010) 'Basel III: International Framework for Liquidity Risk Measurement, Standards and Monitoring', http://www.bis.org/publ/bcbs188.pdf.

Brunnemeier M.K. (2009) 'Deciphering the 2007-08 Liquidity and Credit Crunch', *Journal of Economic Perspectives*, XXIII, pp. 77-100.

Cabral I., Dierick F. and Vesala J. (2002) 'Banking Integration in the Euro Area', http://www.ecb.int/pub/pdf/scpops/ecbocp6.pdf.

Cajueiro D. and Tabak B.M. (2008) 'The Role of Banks in the Brazilian Interbank Market: Does Bank Type Matter?', *Physica A*, CCCLXXXVII, pp. 6825-6836.

Casu B. and Girardone G. (2004) 'Financial Conglomeration: Efficiency, Productivity and Strategic Drive', *Applied Financial Economics*, XIV, pp. 687-696.

Cetorelli N. and Goldberg L.S. (2008) 'Banking Globalization, Monetary Transmission, and the Lending Channel', http://www.nber.org/articles/w14101.pdf.

Chelley-Steeley P. (2005) 'Modeling Equity Market Integration Using Smooth Transition Analysis: A Study of Eastern European Stock Markets', *Journal of International Money and Finance*, XXIV, pp. 818-831.

Cocco J.F., Gomes F.J. and Martins N.C. (2009) 'Lending Relationships in the Interbank Market', *Journal of Financial Intermediation*, XVIII, pp. 24-48.

Cohen H.M., Bennis W.G. and Wolkon G.H. (1961) 'The Effect of Continued Practice on the Behaviors of Problem Solving Groups', *Sociometry*, XXIV, pp. 416-431.

Cumming C.M. and Hirtle B.J. (2001) 'The Challenges of Risk Management in Diversified Financial Companies', *Journal of Financial Transformation*, III, pp. 89-95.
Cyree K.B., Wansley J.W. and Boehm T.P. (2000) 'Determinants of Bank Growth Choice', *Journal of Banking and Finance*, XXIV, pp. 709-734.
Craig B. and Fecht F. (2007) 'The Eurosystem Money Market Auctions: A Banking Perspective', *Journal of Banking and Finance*, XXXI, pp. 2925-2944.
Craig B. and Von Peter G. (2014) 'Interbank Tiering and Money Center Banks', *Journal of Financial Intermediation*, XXIII, pp. 322-347.
Cornett M.M., McNutt J.J., Strahan P.E. and Tehrian H. (2011) 'Liquidity Risk Management and Credit Supply in the Financial Crisis', *Journal of Banking and Finance*, C1, pp. 297-312.
De Lisa R., Zedda S., Vallascas F., Campolongo F. and Marchesi M. (2011) 'Modelling Deposit Insurance Scheme Losses in a Basel 2 Framework', *Journal of Financial Service Research*, XL, pp. 123-141.
De Haas R. and van Lelyveld I. (2010) 'Internal Capital Markets and Lending by Multinational Bank Subsidiaries', *Journal of Financial Intermediation*, XIX, pp. 1-25.
Dematté C. (1981) 'International Financial Intermediation: Implications for Bankers and Regulators', *Banca Nazionale del Lavoro Quarterly Review*, March, pp. 91-110.
Demsetz R.S. and Strahan P.E. (1997) 'Diversification, Size, and Risk at Bank Holding Companies', *Journal of Money, Credit, and Banking*, XXIX, pp. 300-313.
D'Souza C. and Lai A. (2006) 'The Effects of Bank Consolidation on Risk Capital Allocation and Market Liquidity', *Journal of Financial Research*, XXIX, pp. 271-291.
Diamond D.W. and Rajan R.G. (2001) 'Liquidity Risk, Liquidity Creation and Financial Fragility: A Theory of Banking', *Journal of Political Economy*, CIX, pp. 287-327.
Dierick F. (2004) 'The Supervision of Mixed Financial Services Groups in Europe', http://www.ecb.europa.eu/pub/pdf/scpops/ecbocp20.pdf.
Dinger V. and Von Hagen J. (2009) 'Does Interbank Borrowing Reduce Bank Risk?', *Journal of Money, Credit and Banking*, XLI, pp. 491-506.
Drehmann M. and Nikolaou K. (2013) 'Funding Liquidity Risk: Definition and Measurement', *Journal of Banking and Finance*, XXXVII, pp. 2173-2182.
Ehrmann M. and Worms A. (2004) 'Bank Networks and Monetary Policy Transmission', *Journal of the European Economic Association*, II, pp. 1148-1171.
Eisenschmidt J., Hirsch A. and Linzert T. (2009) 'Bidding Behaviour in the ECB's Main Refinancing Operations during the Financial Crisis', ECB working article 1052, May.
European Central Bank (2010a) 'Beyond ROE – How to Measure Bank Performance', http://www.ecb.europa.eu/pub/pdf/other/beyondroehowtomeasurebankperformance201009en.pdf.
European Central Bank (2010b) 'Euro Money Market Study', http://www.ecb.int/pub/pdf/other/euromoneymarketstudy201012en.pdf.
Fecht F., Nyborg K.G. and Rocholl J. (2011) 'The Price of Liquidity: Bank Characteristics and market Conditions', *Journal of Financial Economics*, CII, pp. 344-362.
Fitch (2004) 'Bank Rating Methodology', http://www.fitchratings.cl/Upload/procesoevaluacionbancos%281%29.pdf.
Flannery M.J. (1981) 'Market Interest Rate and Commercial Bank Profitability: An Empirical Investigation', *Journal of Finance*, XXXVI, pp. 1085-1101.
Focarelli D., Panetta F. and Salleo C. (2002) 'Why Do Banks Merge?', *Journal of Money, Credit and Banking*, XXXIV, pp. 1047-1066.
Forsyth D. (2009). *Group Dynamics*. Wadsworth: Cengage Learning.
Furfine C.H. (2001) 'Banks as Monitors of Other Banks: Evidence from the Overnight Federal Funds Market', *Journal of Business*, LXXIV, pp. 33-74.
Furfine C.H. (2002) 'The Interbank Market during a Crisis', *European Economic Review*, XLVI, pp. 908-820.

Freixas X., Parigi B.M. and Rochet J.C. (2000) 'Systemic Risk, Interbank Relations, and Liquidity Provision by the Central Bank', *Journal of Money, Credit and Banking*, XXXII, pp. 611-638.
Garratt R.J., Mahadeva L. and Svirydzenka K. (2014) 'The Great Entanglement: The Contagious Capacity of the International Banking Network just Before the 2008 Crisis', *Journal of Banking and Finance*, XLIX, pp. 367-385.
Gatev E., Shuermann T. and Strahan P. (2009) 'Managing Bank Liquidity Risk: How Deposit-Loan Synergies Vary with Market Conditions', *Review of Financial Studies*, XXII, pp. 995-1020.
Hale G. (2012) 'Bank Relationship, Business Cycles, and Financial Crises', *Journal of International Economics*, LXXXVIII, pp. 312-325.
Hardouvelis G., Malliaropulus D. and Priestley R. (2006) 'EMU and European Stock Market Integration', *Journal of Business*, LXXIX, pp. 365-392.
Ho T.S.Y. and Saunders A. (1985) 'A Micro-Model of the Federal Funds Market', *Journal of Finance*, XL, pp. 977-990.
Holmstroem B. and Tirole J. (2000) 'Liquidity and Risk Management', *Journal of Money, Credit and Banking*, XXXII, pp. 295-319.
Homans, G.C. (1951). *The Human Group*. New Brunswick: Routledge and Kegan Paul.
Institute of International Finance (2007) 'Principles for Liquidity Risk Management', http://www.iif.com/download.php?id=tv/yzuHHXJ0.
Iori G., Jafarey S. and Padilla F.G. (2006) 'Systemic Risk on the Interbank Market', *Journal of Economic Behaviour and Organization*, LXI, pp. 525-542.
Iori G., Renò R., De Masi G. and Caldarelli G. (2007) 'Trading Strategies in the Italian Interbank Market', *Phisica A*, XXXLIIIVI, pp. 467-479.
Iyer R. and Peydró J.L. (2011) 'Interbank Contagion at Work: Evidence from a Natural Experiment', *Review of Financial Studies*, XXIV, pp. 1337-1377.
Joint Forum (2006) 'The Management of Liquidity Risk in Banking Groups', http://www.bis.org/publ/joint16.pdf.
Kashyap A.K., Rajan R. and Stein J.C. (2002) 'Banks as Liquidity Providers: An Explanation for the Coexistence of Lending and Deposit-Taking', *Journal of Finance*, LVII, pp. 33-73.
Kashyap A.K. and Stein J.C. (2000) 'What Do a Million Observation on Banks Say about the Transmission of Monetary Policy?', *American Economic Review*, XC, pp. 407-428.
Masera, R. (2009). *The Great Financial Crisis*. Rome: Bancaria Editrice.
Matz L. and Neu P. (2007). *Liquidity Risk Measurement and Management: A Practitioner's Guide to Global Best Practices*. Chichester: John Wiley and Sons.
Mazzillis M.C. and Schena C. (2001) 'Una lettura dell'evoluzione strutturale ed operativa delle Banche di Credito Cooperativo nel periodo 1983-1999', *Cooperazione di Credito*, LIII, pp. 29-57.
Memmel C. and Sachs A. (2013) 'Contagion in the Interbank Market and Its Determinants', *Journal of Financial Stability*, IX, pp. 46-54.
Mistrulli P.E. (2011) 'Assessing Financial Contagion in the Interbank Market: Maximum Entropy versus Observed Interbank Lending Patterns', *Journal of Banking and Finance*, XXXV, pp. 1114-1127.
Mueller J. (2006) 'Interbank Credit Lines as a Channel of Contagion', *Journal of Financial Services Research*, XXIX, pp. 37-60.
Nyborg K.G., Bindseil U. and Strebulaev I.A. (2002) 'Bidding and Performance in Repo Auctions: evidence from ECB Open Market Operations', http://www.ecb.int/pub/pdf/scpwps/ecbwp157.pdf.
Prati A., Bartolini L. and Bertola G. (2003) 'The Overnight Interbank Market: Evidence from the G-7 and the Euro Zone', *Journal of Banking and Finance*, XXVII, pp. 2045-2083.
Rochet J.C. and Tirole J. (1996) 'Interbank Lending and Systemic Risk', *Journal of Money, Credit and Banking*, XXVIII, pp. 733-762.

Schinasi G.J. and Texeira P.G. (2006) 'The Lender of Last Resort in the European Single Financial Market', http://www.imf.org/external/pubs/ft/wp/2006/wp06127.pdf.
Udhe A. and Heimeshoff U. (2009) 'Consolidation in Banking and Financial Stability in Europe: Empirical Evidence', *Journal of Banking and Finance*, XXXIII, pp. 1299-1311.
Upper C. (2006) 'Contagion Due to Interbank Credit Exposures: What Do We Know, why Do We Know It, and What Should We Know?', Mimeo, BIS.
Upper C. and Worms A. (2004) 'Estimating Bilateral Exposures in the German Interbank Market: Is there a Danger of Contagion?', *European Economic Review*, XLVIII, pp. 827-849.
Vander Vennet R. (2002) 'Cost and Profit Efficiency of Financial Conglomerates and Universal Banks in Europe', *Journal of Money, Credit and Banking*, XXXIV, pp. 254-282.
Wells S. (2004) 'Financial Interlinkages in the United Kingdom's Interbank Market and the Risk of Contagion', Bank of England Working Article n. 230.
Wong K.P. (1997) 'On the Determinants of Bank Interest Margins under Credit and Interest Rate Risks', *Journal of Banking & Finance*, XXI, pp. 251-271.